WHAT IMPEDES THE DEVELOPMENT OF RENEWABLE ENERGY TECHNOLOGY IN EGYPT

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ABSTRACT

Worldwide energy assessments now indicate that improving the energy efficiency and sustainability of buildings, appliances, office equipment, factories, and vehicles could free-up more than a trillion dollars per decade. In addition, these improvements would prevent the release of a rash of environmental pollutants. Greater reliance on sustainability offers countries worldwide a means of maintaining economic growth and environmental quality.

This study is part of continuing research work carried out by the researchers at the EDRG (Environmental Design Research Group) at the AAST (Arab Academy for Science and Technology) in Alexandria, Egypt on the application of sustainability and renewable energy in Egypt. The work presented in this paper is a preliminary study conducted in the field of renewable energy and more work is being done on it. This paper discusses briefly the energy statistics in Egypt and the challenging need to properly implement the usage of renewable energy. What impedes the wide spread of this technology and what are the ways to promote it? The paper discusses the current state of Egypt's renewable energy usage and the energy sources already in use in the country.

In spite of the Egyptian government apparently is one of the first governments of the developing countries to realize this problem and to sign the Kyoto Protocol to the United Nations Framework Convention on Climate Change. However, as Egyptian residents, we are very unaware of these efforts. The vast majority of Egyptians may not even understand the meaning of the term 'renewable energy.' But, the Global Warming is expected to destroy a big part of the Delta in the next decade with a noticeable percent which will affect the Delta population. So far the Egyptian renewable energy program didn't achieve its goals in reasonable usage of renewable energies, while Egypt has lots of potentials (Solar, Wind and Biomass resources….).

Keywords: Renewable Energy, Global warming, Public Awareness, Energy usage

1. Introduction

The world is getting hotter. Industry, vehicles and homes burn fossil fuels releasing gases that trap the sun's energy. These gases also change the weather: storms, floods and droughts are becoming more common [1]. With the oceans warming and expanding, the sea level will rise; threatening coasts and small islands with flooding [2]. Higher temperatures will speed up the development of parasites [3]. This is all leading to what is known now as Global warming, problem which has changed the world concerns to reconsider the pollution sources

affecting planet earth, with a major concern towards remarkable increase in carbon dioxide emissions all over the world in the last decade.

Renewable energy is the solution for that catastrophe happening to the world, finding new, clean and sustainable energy sources. Initially applying solar, wind, water, nuclear and biomass energy is the solution. Through the current world concern with searching about new energy resources; supporting renewable energy technologies already in use in Egypt, increasing the efficiency of the current systems in use and promoting renewable energy technologies throughout the country. The UN and other international organizations are supporting a lot of projects and programs especially in developing countries. In this paper the results of some Renewable Energy Projects implemented in Egypt are discussed along with their Opportunities and Barriers.

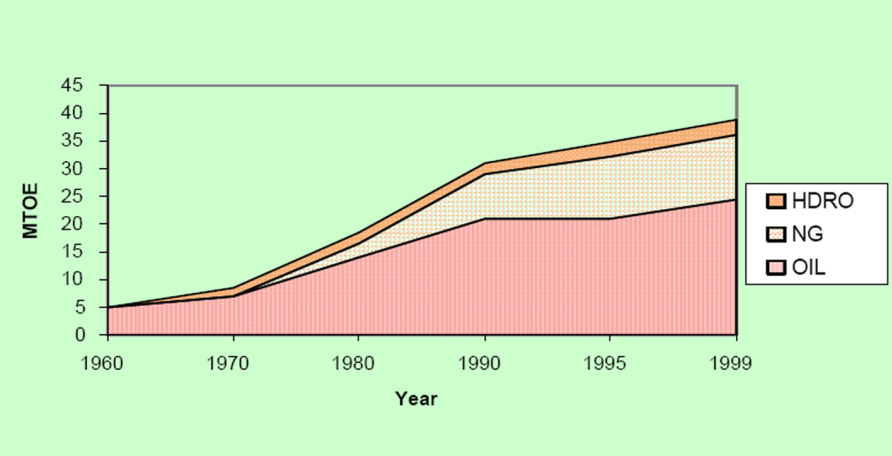
2. Energy Statistics & Policy In Egypt

As stated by Greenpeace, Egypt is currently at 'energy – crossroad.' Conventional fuels are becoming increasingly expensive and are soon to be scarcer. Natural gas and oil reserves will run out in about 30 or 40 years [4]. Thus the transition to alternative energy sourcing is crucial now than ever for Egypt. Fossil fuels, hydropower and non-commercial fuels (e.g. firewood, agricultural wastes and dried dung) are the main energy sources in Egypt at present [2]. Currently, Petroleum fuels (oil & natural gas) are the most important energy sources. All these energy activities in use are some of the major sources of pollution which threat the ecosystem, land water and air.

3. Egypt's Energy Situation

3.1. Background

The energy sector plays a major role in Egypt's economic development. The energy sector in Egypt is managed through two different ministries, The Ministry of Electricity and Energy (MOEE) and the Ministry of Petroleum (MOP). Egypt has various forms of conventional energy resources such as petroleum, hydropower, and coal. Petroleum includes crude oil and natural gas. The energy infrastructures for oil, gas, and electricity in Egypt are adequate and covering most of the populated areas in the country. This conventional energy resources consumption is shown in Figure 1.



Consumption in the last 5 decades [4]

Covering the Renewable energy sector in Egypt the *The New and Renewable Energy Authority* (NREA) was established in 1986 as an integral element of national energy planning. Its main objectives include the application of these mature technologies in Egypt [4]; and the establishment of testing and certification facilities and development of local standards and codes.

It SEEMS, according to many sources, papers and figures published by Egyptian and International bodies that Egypt is working in order to overcome greenhouse effects and global warming problems and introduce the utilization of renewable energy as an alternative. The NREA originally aimed at supplying 3% of Egypt's electricity in 2010 using renewable energy, on its establishment in 1986 [4]. We are now three years away from this aim, and the percentage of electricity produced by renewable energy is still unclear. However, a new figure has been published; the NREA now aims to supply 14% of Egypt's electricity by renewable energy by the year 2020 [4,5].

3.2 Egypt's Sustainable Energy demand

Securing energy resources and production to meet the national demand both on the short and long terms, along with adequate attention to environmental concerns, are considered vital elements for sustainable development [6]. Hence, to face these challenges Egypt has adopted different measures to increase the role of *Rational Use of Energy* (RUE) and *Renewable Energy* (RE) in the energy supply and use matrix. The NREA implements the RE strategy and update it in view of evolving RE trends. NREA mandate included the development of RE resources as well as conducting information dissemination and training programs to raise the public awareness on RE. However, RUE activities are scattered among several entities is very much less developed. This hinders its evolution and decreases its impact in the total energy scene.

4. RET (Renewable Energy Technology) Applications in Egypt.

As mentioned earlier Egypt is one of the first countries in the developing world to sign the Kyoto protocol.

Figure 2: Some sources of Renewable Energy applied in Egypt

Article 2 of the protocol stipulates that the parties which signed it should research, promote, develop and increase the use of new and renewable forms of energy, as well as of advanced and innovative environmentally sound technologies. From the researchers point of view not enough research or application is done in Egypt in this field and more work can be undertaken. As a matter of fact, RE has received more attention and growth due to the existence of a national organization (NREA) taking the responsibility of developing its activities. Mostly all the solar, wind and biomass technologies were field-tested in Egypt. Figure 1 presents some of the commercially exploited RET's in Egypt.

There are currently 15 projects being undertaken in the field of RE in Egypt The electricity generation potential from wind energy in Egypt is very high. The estimated potential in the Western Bank of Gulf of Suez is 20000 MW, which is almost equal to the overall installed capacity in 2004/2005. The present grid connected wind power plants installed capacity reached 230 MW, while the short term plan targets 850 MW by year 2010 or about 3% of electricity demand; the long term target is to reach 3000 MW by 2021/2022 or about 7% of electric demand all on the Gulf of Suez, saving about 3 Mtoe annually. There are also about 200 thousand domestic solar water heating units installed now in Egypt where the typical unit contains 2 square meters of flat plate collector's area and 150 litres storage saving about 0.085 Mtoe annually.

4.1 Types of RE sources in Egypt
(Solar Energy, Wind Energy, Hydro-Power and Biomass)
4.1.1 Implementation of Solar energy in Egypt

A. Solar Thermal water heating (STWH) for domestic and commercial sectors:

A solar thermal technology is a simple system but there are some minor faults that can lead to serious problems, especially when they are not detected early. Many installations have not performed as expected due to low level of awareness and some technical problems provoked by lack of maintenance. Figure 3 (a) shows the installation of solar thermal tubes.

B. Solar thermal electricity generation

Solar thermal electricity generation has existed for a number of decades. The principle of operation is very simple. Steam is generated by concentrated solar heat. This steam is then used to operate a steam turbine which turns a generator to make electricity as shown in Figure 3 (b). This electricity can be further used to make hydrogen. Steam turbine power plants burn fossil fuels to create the heat necessary to boil water and run a turbine. Burning fossil fuels creates green house emissions which contribute to global warming and polluted air.

Existing steam power plants can be increased by adding solar heat to the existing fossil fuel plant, thereby reducing the amount of fossil fuels required. A retrofitted plant without thermal storage could generate electricity during the day from sunlight, and at night with fossil fuel. This would be the most economical plant retrofit. In this setting, a plant may be able to reduce the amount of fossil fuels

required by 50 to 75% since most electrical generation is required during daylight hours when indu

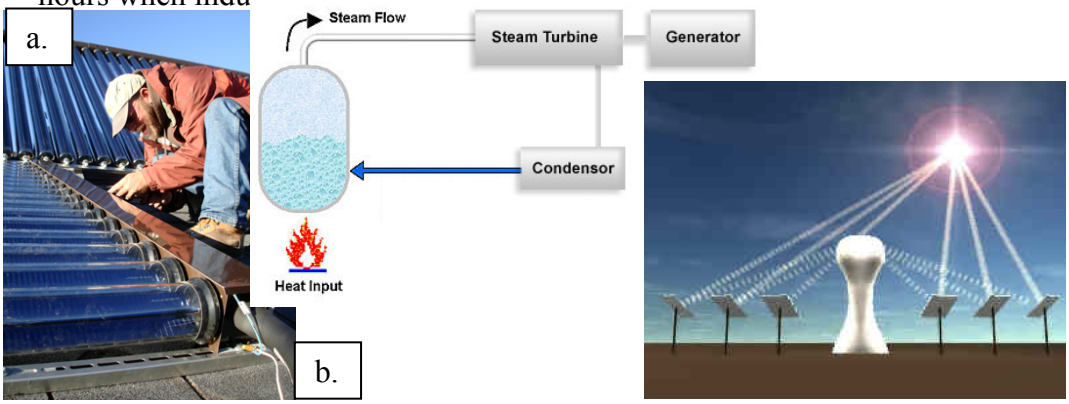


Figure 3: (a) Solar Thermal Heating Tubes; (b). (Steam Turbines power plant)

C. Solar Water Heater Application in Egypt:
The following project is a project undertaken in Minia Magaga village in Egypt by the NGO photos of which shown in Figure 4.

Figure 4: Solar Water Heater, Model Village Friendly with the Environment (Minia-Magaga, Egypt)

Project's objectives:
Distributing the appropriate technologies and utilizing the solar energy in the daily activities by installing 69 solar heaters in Kom El Akhdar Village within one year. To conduct awareness seminars for the community and train three of the youth on how to install, maintain and service the solar heaters. To establish and manage a warehouse for solar heaters spare parts in the NGO. One of the main problems of this project is that the trained technicians left the village and the NGO did not prepare a plan for sustainability after the completion of the project.

4.1.2 Implementation of Photovoltaic Technologies in Egypt

In Egypt efforts are directed at developing the use of photovoltaic for electricity production and pumping of groundwater which is the most cost effective option for the currently energy requirements. There are few traditional or professional applications financed on commercial terms and numerous donors [7]. Photo in Figure 5 depicts photovoltaic field in Kuraymat, Egypt.

Solar Energy Applications *(Kuraymat, Egypt)*

Figure 5: Photovoltaic field at Kuraymat, Egypt

Sun's Energy *(We have the SUN!!);*

- Solar Cells: (called "photovoltaic" or "photoelectric" cells) that convert light directly into electricity. In a sunny climate, you can get enough power to run a 100W light bulb from just one square metre of solar panel.
- Solar water heating: Where heat from the Sun is used to heat water in glass panels on your roof. This means you don't need to use so much gas or electricity to heat your water at home. Water is pumped through pipes in the panel. The pipes are painted black, so they get hot when the Sun shines on them.
- Solar Furnaces: Solar Furnaces use a huge array of mirrors to concentrate the Sun's energy into a small space and produce very high temperatures.

4.1.3 Implementation of Wind energy in Egypt

One asset which Egypt can definitely capitalise on is its sizeable wind energy potential, particularly in coastal areas on the Red Sea coast and in the south western regions of the country. The first wind farm with a capacity of 400kw was installed in Ras Ghareb on the Red Sea coast in 1988, to serve one of the oil companies. In 1992, the second wind farm was installed in Hurghada. Some 45 percent of its components were locally manufactured. The farm has been connected to the national grid since 1998 [4]. With its 230 MW wind farms installed capacity, Egypt is on top of all African and Middle Eastern countries in grid-connected wind power generation plants.

Since the late 1970s, Egypt started considering the use of RE where several bilateral and multilateral agreements were signed and implemented to explore potential horizons of RE use. Of equal importance, is the willingness of developed countries that already have an advanced record in wind resource utilization and in its equipment manufacture, to cooperate with Egypt and offer adequate financing facilities from the beginning, particularly to compensate for the higher cost of RE compared to conventional one which would facilitate wind power projects

development. Such countries included Germany, Denmark and at the beginning, then currently include Spain and Japan.
Germany has been cooperating with Egypt in the field of RE for decades, and has already taken major strides in this domain [8].

Advantages; one of the main advantages is that wind is free, wind farms need no fuel. The technology produces no waste or greenhouse gases. The land beneath wind farms or wind turbines can usually still be used for farming. The can also be tourist attractions. Finally, it's a good method of supplying energy to remote areas.

Disadvantages; some of the known problems is that the wind is not always predictable, some days have no wind. Suitable areas for wind farms are often near the coast, where land is expensive. Some people feel that covering the landscape with these towers is unsightly so visual problems. Can kill birds as migrating flocks tend to like strong winds. Some other problems associated with its implementation are that it can affect television reception if you live nearby and can be noisy that is why it's recommended to have such farms in free lands. Having said that, as aerodynamic designs have improved, modern wind farms are much quieter

4.1.4 Implementation of biomass in Egypt

In most developing countries, biomass combustion provides the largest component of total national fuel use. It is burned to provide heat for cooking, crop drying, factory processes etc. "Bioconversion" uses plant and animal wastes to produce fuels such as methanol, natural gas, and oil. The term biomass covers a large number of materials with highly different properties which can be used as fuels. We can use rubbish, animal manure, woodchips, seaweed, corn stalks and other wastes. In rural areas, biomass is likely to be the cooking fuel for many years to come.

Advantages; It makes sense to use waste materials where we can and it fuel tends to be cheap. Makes waste and unwanted stuff a worthy thing. It puts less demand on the Earth's resources as most renewable resources.

Disadvantages; Collecting the waste in sufficient quantities can be difficult. We burn the fuel, so it makes greenhouse gases. Some waste materials are not available all year round.

4.1.5 Implementation of Hydro-power in Egypt

Hydropower is today the most important kind of renewable and sustainable energy [9]. Water is pumped up to the top reservoir at night, when demand for power across the country is low. When there's a sudden demand for power, the "head gates" (huge taps) are opened, and water rushes down the tunnels to drive the turbines, which drive the powerful generators. The water then collects in the bottom reservoir, ready to be pumped back up later [10].

Egypt has one of the most important dams in the world the Aswan High Dam (Shown in Figure 6) that Controls the World's Longest River, the Nile, in one of

the world's third largest reservoir, Lake Nasser. The dam, known as Saad el Aali in Arabic, was completed in 1970 after ten years of work. [9]

Figure 6: Photo depicts the master plan of the Suez Canal Dam [9]

Advantages; Once construction is completed, operating costs are very low. No waste or pollution is produced. This technology is very reliable. The water can be stored behind the dam to deal with peaks in demand. Power output can be increased very quickly to meet sudden demand. Electricity can be generated constantly. In Egypt it controlled the annual floods on the Nile River and prevents the damage which used to occur along the floodplain [11]. Provides about a half of Egypt's power supply and has improved navigation along the river by keeping the water flow consistent. The Dam was a successful project, giving Egypt and northern Sudan extra farmland and providing electricity for Egyptian cities.

Disadvantages; Dams are very expensive to build. Large-scale flooding may cause environmental problems. Suitable sites for their erection are limited.

5. Barriers and Opportunities Facing Renewable Energy Development

The NREA have analyzed the applied renewable energy systems in Egypt, to find out barriers and opportunities facing each system. Literature reviews, questionnaires and interviews were performed on different parties including manufacturers, organizations and agencies, users and owners. Responses received through the questionnaires and interviews were analyzed, and the barriers were classified into the following categories:

- Technical and social awareness isn't available.
- Costs of renewable energy technologies are expensive and aren't subsidized as conventional energy.
- NGO's aren't taking an action in the publication of renewable energies.
- Shortage of local market for renewable energy resources which increases its cost and limitation to a certain economical standard.
- Lack of maintenance for installed systems.
- No restrict regulations, legislation, obligations and penalties on companies and related parties for different activities (design, manufacturing, tender's specifications, system acceptance, maintenance…etc.)

Among other barriers hindering the development of RUE and RE are:

- Economic and financial barriers due to subsidized conventional energy prices.

- The absence of well defined legislation supporting RUE or RE institutional barriers of having two ministries responsible for energy issues which make integrated energy planning more difficult.

Abridging the access between the Egyptian market and other international markets. Experts find that other energy prices are cheaper, which is one of the economic barriers of PV technology. The fact that the information spread among consumers is inadequate is also another barrier. The main technical barriers faced by experts are the lack of skilled personnel in PV technology. In addition, the transfer of the technology is difficult [12] and experts feel that, in order to be economical, there needs to be a minimum level of production in Egypt.

6. Objectives and Recommendations

It is clear that there are marketability problems in Egypt, as users are generally unaware of these problems, and also because users, often due to lack of awareness, feel that they can't afford the technology, without considering the long-term benefits. Therefore, a study needs to be conducted on how to MARKET and PROMOTE PV and RE technology and the benefits people will reap from it in return.

To further widen the circle of PV and RE users in Egypt, the top decision-makers themselves, who usually have a very low level of awareness of the systems, need to be educated. Study tours of various PV and RE industries and some successfully working projects may be efficient. Also, the decision makers themselves should not be limited to the energy sector only, but should represent a mix of all the sectors involved in the systems.

Other main problem is the lack of awareness of the public of what renewable energy is and how it can help us reduce the problems of global warming and climate change. This needs to be backed by the different media sources, the NHO's and the government who all need to work together to spread awareness about the problems the globe is facing and the urgent need of using renewable energy sources on different levels.

From the authors point of view one of the main obstacles facing the RE development in Egypt is the Governmental backing and high percentage of subsidy placed on conventional energy resources. This subsidy if to be removed or reduced by the government, both those interested in the market and the users will find no place to turn but to the development and usage of RE resources.

Funding needs to be organized, on many levels, whether from the government, the private sector, donor agencies and international organizations (e.g. several German organizations are contributing in expanding the wind farms of Egypt). All those efforts need a strong backup from the government. It is indispensable to raise the awareness of members of the Egyptian public society (local awareness), on **ALL** levels and not just direct users, of the environmental problems that we are facing and will soon suffer from (the running out of fossil fuels, the hole in the ozone layer, global warming, the need to recycle and conserve energy, etc.)

7. Conclusion

Lastly, there is another important part affecting the success of any proposed sustainable energy development approach, which is the *energy end-user*. All proposed policies are often drafted, revised, approved, and adopted by technocrats and professionals representing only the supply side of the energy chain. This scheme had functioned well for the conventional forms of energy (being commodities) like electricity, NG, and oil products. However, the same scheme has failed to succeed in the case of RUE and non bulk RE utilization as in most of the cases the end user find him self requested to get involved in a process much different from just buying a commodity.

To be successful, RUE and RE strategies together with accompanying tools and measures have to be developed through deep negotiations and intimate involvement of end users associations. To do this a thorough understanding of the end users need to be available, thus in the authors point of view one of the most important barriers that needs a quick solution is the user or local awareness problems. Our society needs to know more about global warming and need to understand what is RE and RUE through media, governmental awareness programs, educational sectors and others. To promote and aware students within all education levels about the use of RET to decrease carbon dioxide emissions all over the world and save our planet from global warming disasters as today's kids are tomorrows men.

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